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Li-Ying, Jason; Paunova, Minna; Egerod, Ingrid

Published in:
Journal of Nursing Management

Link to article, DOI:
[10.1111/jonm.12404](https://doi.org/10.1111/jonm.12404)

Publication date:
2016

Document Version
Peer reviewed version

[Link back to DTU Orbit](#)

Citation (APA):
Li-Ying, J., Paunova, M., & Egerod, I. (2016). Knowledge sharing behavior and intensive care nurse innovation: the moderating role of control of care quality. *Journal of Nursing Management*, 24(7), 943-953.
<https://doi.org/10.1111/jonm.12404>

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Li-Ying, J., Paunova, M., & Egerod, I. (2016). Knowledge sharing behavior and intensive care nurse innovation: the moderating role of control of care quality. *Journal of Nursing Management*, 24 (7): 943-953.

Knowledge sharing behavior and intensive care nurse innovation: the moderating role of control of care quality

Abstract

Aims: This study investigates the influence of ICU nurses' knowledge sharing behavior on nurse innovation, given different conditions of care quality control.

Background: Healthcare organizations face an increasing pressure to innovate while controlling care quality. We have little insight on how control of care quality interacts with knowledge sharing behavior of ICU nurses to affect their innovative behaviors.

Methods: We developed a multi-source survey study of more than 200 ICU nurses at 22 ICUs of 17 Danish hospitals. Two versions of questionnaire were used – one designed for nurse employees and the other for the managing nurse(s). An OLS regression analysis is used to test the hypotheses.

Results: Different aspects of knowledge sharing affect innovation differently, depending on the strength of control of care quality within the unit.

Conclusions: The increasing pressures to implement control of care quality *and* innovate may be conflicting, unless handled properly

Implications for Nursing Management: Process control at ICUs should be loosened, when personal interaction between ICU nurses is encouraged to stimulate nurse innovations. Alternatively, managers may develop a climate of helping others, especially younger colleagues, to offset the negative effects of strong process control.

Introduction

Health care organizations have witnessed an increasing number of evidence-based innovations, some of which come from the creative potential of health care professionals. Recent developments in health care management have recognized that frontline clinicians, who are the key to safety and care quality, are not only important for the adoption of innovations, but also the origins of change in clinical practice, thus an important *source* of innovation (Hughes 2006; McSheery & Douglas 2011). In the health care system, nurses provide up to 80% of primary care and are thus well positioned to contribute to innovations in clinical practice (Hughes 2006). Therefore, encouraging innovation behaviors among nurses has been an important development direction for healthcare scholars (ICN 2009) and there is a need of research in nursing innovation (Tross & Cavanagh 1996; Blakeney et al. 2009; McSheery & Douglas 2011; Suhonen & Paasivaara 2011).

Following the definition of nursing innovation as “the encouragement of professionals to utilize their acquired knowledge and skills to creatively generate and develop new ways of working, drawing on technologies, systems, theories and associated partners/stakeholders to further enhance and evaluate (nursing) practice” (McSherry & Douglas 2011: 165), we notice that there has been a solid body of research on the contextual factors for nurse innovation, including nurses’ challenges to embrace change (Stevens 2001), transformational leadership (Weng et al. 2015), organizational and social climate (Richer et al. 2009), and training (Syme & Stiles 2012). While these contextual factors are important for nurse innovation, innovations will not take place unless knowledge gained by motivated and competent nurses is shared among them. Human capital in the nursing profession is critical for the success of innovative projects (Suhonen & Paasivaara 2011), but individual abilities, knowledge and skills do not exist in a vacuum; instead, they must be effectively and interactively shared. The literature on knowledge management has a long tradition in suggesting that active knowledge sharing enhances individual innovative performance (Cummings 2004). To date, we have little knowledge about how nurses’ knowledge sharing behavior in different modes is related to nurse innovation within intensive care units (ICUs).

Meanwhile, another critical role that practical clinicians, such as ICU nurses, play is their contribution to the quality of care (Pronovost et al. 2001; Nelson et al. 2006). Health care organizations put a premium on developing, implementing and evaluating measures for quality of care (Pronovost et al. 2001; Rademakers et al. 2011). These measures are used as a *control* mechanism in nursing management to ensure the quality of care provided to patients. To date, we have little insights on the possible influence of care quality control on nurse innovation, particularly as it interplays with knowledge sharing behavior. Thus, we pose the following question: would the control of care quality at ICUs make a difference for innovation when ICU nurses share their knowledge?

Following this line of inquiry, this study develops a number of hypotheses, based on the literature in knowledge management, innovation, and quality of care. The empirical base is a survey conducted with the “Forskernetværk for Intensivsygepleje” (Research network for intensive care nurses), reaching out to a population of ICU nurses in Denmark. We aim at providing implications for nursing management with regard to how to foster nurse innovations by promoting knowledge sharing and adjusting control of care quality.

Literature overview and hypotheses

Knowledge sharing and innovation

Innovation consists of an ongoing pursuit for new and unique knowledge, which is created through a continuous process where boundaries and constraints stemming from limited individual cognition are extended and overcome by acquiring a new context, a new view of the world, and new knowledge (Subramaniam & Youndt 2005). By interacting and sharing knowledge with others, an individual may enhance his or her capacity to define a situation or problem, and apply his or her knowledge so as to

act and solve the problem (Nonaka et al. 2006). Knowledge sharing can be defined as a social interaction, involving the exchange of employee knowledge, experiences, and skills as well as the provision or receipt of task information, know-how, and feedback regarding a practice or procedure (Cummings 2004).

The literature in knowledge management has shown that different means and processes of knowledge sharing within various types of organizations have positive impacts on individual, team and organizational innovation capabilities (Hu & Randel 2014; Sáenz et al. 2009; Wang & Wang 2012). Therefore, it is commonly recognized that knowledge sharing is essential for creating new knowledge and innovation (Dalkir 2005).

Knowledge sharing in ICU nurse groups might entail developing coaching and guidelines, engaging in peer review, development of and contributing to research committees, seminars, journal clubs, and newsletters to update research skills. ICU nurses may also share knowledge in informal ways such as chatting in the coffee room and canteen, sharing experiences that may benefit the group on ICU nurse meetings and other informal occasions, and/or communicating on professional online communities. By engaging in these knowledge sharing activities, it is expected that ICU nurses may become more innovative in general. Based on the ideas derived from the nursing practice and shared within the unit, more evidence-based innovations can be initiated and developed with the help of other clinicians and the support of leadership and management (Åmo 2006). The discussion above suggests the following hypothesis:

***H1:** Knowledge sharing among ICU nurses is positively associated with ICU nurses' innovation.*

Control of care quality in relation to innovation

Quality of health care has become an international policy issue (Pronovost et al. 2001). Health care providers are increasingly interested in having objective measures of quality and information about their performance. As consumers, payers, and regulatory agencies require evidence regarding quality of care, the demand for ICU quality measures has been growing.

ICU nurses face various types of performance obstacles in performing patient care tasks, threatening the quality and safety of care provided (Gurses & Carayon 2007). Among others, quality of care has become a major issue in ICUs (Donchin et al. 1995). Therefore, health management practitioners have paid a great attention to implementing controls through the measures of care quality in ICUs (Pronovost et al. 2001; Rademakers et al. 2011).

Efforts have been made to specify and develop ICU quality indicators (Berenholtz et al. 2002). Pronovost and colleagues (2001) suggested that measures of care quality in ICUs can be categorized into structure, process, and outcome measures. In many instruments designed to measure patients' experiences with quality of healthcare, such as the American Consumer Assessment of Health Plans and Providers and the Dutch Consumer Quality-index, elements of all three components are indeed used. Other researchers further developed and tested the care quality measures following this

measurement design and found differentiated effectiveness across different types of measures of care quality (Nelson et al. 2006; Rademakers et al. 2011).

While a comprehensive and well-implemented measurement system of quality of care at ICUs is important to ensure and improve care quality, a strong control by excessive use of measures of care quality may have some disadvantages (Snell 1992). First, high levels of control over performance measures tend to make ICU nurses' practice highly oriented towards operational excellence instead of creating new paths (Spear 2005). Thus, the positive effects created by knowledge sharing on innovation might be compromised in a way that shared knowledge is mostly put into use to make incremental improvements of existing processes and methods instead of initiating boundary-breaking initiatives and trying out new approaches in care provision. Second, clinicians' innovation generally needs leadership support and encouragement (Weng et al. 2015). Thus, excessive use of measures of care quality at ICUs may impose overwhelming management burden onto ward nurses, research nurses, and manager nurses. The consequence is that these leading nurses will have little time and motivation to facilitate knowledge sharing and stimulate innovative ideas within the ICU. Recent studies, such as the Michigan Keystone (e.g., Goeschel & Pronovost 2008), support this argument and highlight the importance of leadership. For instance, workload redistribution can support increased quality of care by enabling ward managers to spend less time on administrative tasks, saving more time to spend with patients, and leading nursing peer review as a means of knowledge sharing (George & Haag-Heitman 2011), and focusing on the issue of innovation and increasing effectiveness (Locke et al. 2011). Based on these arguments, we hypothesize the following:

***H2:** The level of control of quality of care moderates the positive relationship between knowledge sharing among ICU nurses and their innovation in a way that the higher level of control of care quality, the less evident such a positive relationship.*

Data and methods

Instrument and pilot study

To test our hypotheses, we deploy a research design of quantitative methods with a multi-source survey. We developed two versions of a survey questionnaire – one designed for nurse employees (employee version) and the other for managing nurse(s) (manager version). The employee version was designed to tap into innovation, knowledge sharing behaviors, and control variables (e.g., individual demographics). The manager version captured control of care quality, as well as questions about hospital and ICU size (e.g., number of beds). The constructs were all measured with validated psychometric instruments on five-point Likert scales (see Appendix for a list of survey items used). Prior to choosing the instruments, we conducted in-depth interviews with a small number of ICU nurses at various hospitals in Denmark in order to evaluate the extent to which the construct and scales developed outside of Denmark are applicable to the Danish context. In January 2014, we conducted a pilot study in a large Danish hospital with four intensive care units, including 11 manager

and 62 employee responses. The pilot study included open questions, where respondents could share any comments on the survey instrument. After the pilot study, several follow-up interviews were conducted over the phone and face-to-face with a number of respondents, who gave suggestions on how to refine the questionnaire in terms of clarity and comprehension. The psychometric properties of the instruments were further evaluated to reach the final version of the questionnaire.

Ethical approval

Ethical approval was obtained from the “Forskernetværk for Intensivsygepleje” (Research network for intensive care nurses in Denmark). Respondents provided consent by answering the questionnaire and the confidentiality of the individual participants’ responses was ensured.

Sample

In June 2014, we distributed the final Web-based questionnaire through the professional network of Danish intensive care researchers. The questionnaire was sent to 45 researchers, members of the network, reaching 39 intensive care units at 29 different hospitals across Denmark. The hospital that participated in the pilot study was excluded. These researchers received the two versions of the questionnaire and were asked to further distribute the questionnaires within their units to at least one manager/head nurse (manager version) and to all regular nurses (employee version). Finally, 254 nurses completed the employee version and 67 nurses completed the manager version. Because of the requirements of sample matching, usable data at both employee and manager level were collected from 22 units in 17 hospitals, resulting in a final usable sample of 180 regular ICU nurses¹. 94.5% of these nurses were female, and the mean age was 44. On average, respondents had almost 17 years of nursing experience and 80% had completed a two year intensive care nursing certification.

We are aware that a Web-based survey design holds a number of possible biases. We tested for the most important possible bias, namely response bias (Armstrong & Overton 1977), a potential problem that some innovative nurses and those who share knowledge more than others were more likely to answer the questionnaire. The ICUs from which we received responses and those from which we had no responses are not significantly different in terms of size (i.e., number of beds: diff. = -1.46, $t(40) = -0.87$, $p > 0.10$), leading us to conclude that our final sample of ICUs is representative. To test for the potential bias at the individual respondent level, we followed Jeppesen and Frederiksen (2006) and compared the earliest 10% of respondents with the last 10% of respondents and tested for differences in the self-reported measures of (a) innovation (diff. = 0.04, $t(34) = 0.23$, $p > 0.10$) and (b) knowledge sharing (diff. = -0.02, $t(34) = -0.17$, $p > 0.10$). Since no significant differences between these two groups were found, response bias was not a concern.

¹ The entire population of Danish intensive care nurses approximates 2000 nurses. Thus, a returned sample of 112 observations should be sufficient to achieve a low margin of error (3%) and high confidence level (95%), assuming normal distribution (Bartlett et al. 2001).

A second potential bias of our design is common method bias, which cannot be completely ruled out since the dependent variable (innovation) and one of the predictor variables (knowledge sharing) were measured by self-reporting. Even though the widespread condemnation of this method is most likely exaggerated (Crompton & Wagner 1994; Lindell & Whitney 2001; Spector 2006), to lessen the potential bias of common method bias, several procedures were implemented. First, we assured anonymity and confidentiality of the respondents' responses, while the online survey platform disallowed respondents to return to a previous page, making retrospect editing of answers impossible. This design of the questionnaire may reduce the potential common method bias (Podsakoff et al. 2003). Second, since multi-source design of questionnaire to a great extent reduces the potential common method bias (Lindell & Whitney 2001), our study had a multi-source data collection design: control of care quality was measured with data collected from nurse managers rather than nurse employees. Furthermore, it has been argued that moderation effects, such as the one we have found, cannot be caused by common method variance (Chang et al. 2010). Hence, we are confident that common method variance is not a serious problem of this study.

Measures

Innovation. In the employee version of the questionnaire, we used the four general innovation performance items developed by Welbourne et al. (1998) to capture nurse innovation. This scale reflects not only the development of novel and useful ideas, but also the implementation and application of these ideas. The items are powerful in revealing the true potential of nursing innovation, without risking measuring concrete innovation outcomes such as specific new technologies, product prototypes, services, and organization designs, etc., that tend to be highly context specific and not equally applicable across ICUs. Respondents rated their innovation performance ("When I'm at work, I'm good at...") on a five-point Likert scale. The items are shown in Appendix ($\alpha = 0.88$).

Knowledge sharing. We adapted a measure of knowledge sharing behaviors developed by Yi (2009). This measure was included in the employee version and included 18 items with three subscales ($\alpha = 0.86$). Respondents were asked to indicate how often they engage in a certain behavior (see Appendix). The three types of knowledge sharing, namely through written contributions ($\alpha = 0.76$), organizational communication ($\alpha = 0.86$), and personal interaction ($\alpha = 0.69$) were each measured with 6 items.

Control of care quality. Measures of control of care quality were adapted from Pronovost et al. (2001) and were included in the manager version of the questionnaire. Control of care quality includes fifteen items in three subscales ($\alpha = 0.86$): structure, process and outcome control. Structure measures refer to how care is organized; process measures refer to what care providers do; outcome measures capture what happens to patients. Respondents were asked to indicate the extent to which they agree with the statements with regard to the control of care quality (see Appendix for the full list of items). In the case that more than one manager filled out the questionnaire, intraclass correlations coefficient (ICC) was calculated to estimate within-unit similarity in managers' perceptions of control. The individual

ratings ($ICC(1) = 0.17$) and the reliability of mean ratings ($ICC(K) = 0.31$) were adequate, particularly given the very small number of respondents within each unit (LeBreton & Senter 2008).

Controls. We controlled for sex, age, and nursing experience. We also controlled for the number of working hours per week and whether a nurse has had completed official intensive care nursing training. All these measures were collected in the employee version. We attempted controlling for several hospital- and ICU-level variables, collected in the manager version, such as number of beds and number of full-time nurses. Since none of these variables was significant, they are omitted from the analyses presented below.

Results

The summary statistics and correlations among the variables are presented in Table 1. The patterns of correlations generally follow the expected directions. To test the hypotheses in this study, we performed an ordinary least squares (OLS) regression analysis. Table 2 presents the results of this analysis. Model 1 regresses innovation on the control variables. Model 2 tests Hypothesis 1 by including the three types of knowledge sharing into the set of independent variables. All three types of knowledge sharing, namely knowledge sharing through written contributions ($\beta = 0.37, p < 0.01$), organizational communication ($\beta = 0.41, p < 0.01$), and personal interaction ($\beta = 0.20, p < 0.05$), were positively related to innovation. Thus, Hypothesis 1 is supported. To rule out multicollinearity between the different types of knowledge sharing behaviors, we also estimated the variance inflation factors (VIF). There were no signs of multicollinearity, as all VIF were below the conservative cut-off value of 5 (mean VIF = 1.84). We tested Hypothesis 2 in Models 3 to 7. Model 3 also includes the main effect of control of care quality, which is not significant ($\beta = 0.13, p > 0.10$). The following three models respectively include the interaction terms between control of care quality and knowledge sharing through written contributions (Model 4; $\beta = 0.25, p > 0.10$), organizational communication (Model 5; $\beta = 0.03, p > 0.10$) and personal interaction (Model 6; $\beta = -0.41, p > 0.10$). None of these interaction terms are significant. Finally, Model 7 includes all three interaction terms, namely between control of care quality and knowledge sharing through written contributions ($\beta = 0.53, p > 0.10$), organizational communication ($\beta = -0.13, p > 0.10$) and personal interaction ($\beta = -0.59, p < 0.05$). Only the interaction term of personal interaction is significant in the expected negative direction. Furthermore, the main effect of knowledge sharing through personal interaction is significant ($\beta = 2.73, p < 0.05$). These results, which provide partial support to Hypothesis 2, are plotted in Figure 1.

Insert Table 1 about here

Insert Table 2 about here

Insert Figure 1 about here

Auxiliary analyses

Even though we found partial evidence supporting Hypothesis 2, the finding that control of care quality had a moderating effect only on the relationship between personal interaction and innovation was unexpected. Therefore, we decided to conduct auxiliary analyses to investigate how each component of control of care quality moderates the relationship between knowledge sharing and innovation. These analyses are presented in Table 3. First, Model A1 presents the main effects of all control variables, three aspects of knowledge sharing and three types of control of care quality. Knowledge sharing through written contributions ($\beta = 0.49, p < 0.01$) and organizational communication ($\beta = 0.47, p < 0.01$) are positively associated with innovation. However, as Model A1 shows, unlike overall control of care quality which was not related to innovation in the main analysis, process control is marginally negatively related to innovation ($\beta = -0.37, p < 0.10$), whereas outcome control is positively related to innovation ($\beta = 0.56, p < 0.05$). The next three models further investigate the potential moderating effects of structural control (Model A2), process control (Model A3) and outcome control (Model A4) on the relationship between knowledge sharing and innovation. Of these auxiliary models, Model A3 is the only model that results in significant interactive effects. In particular, the effect of process control on the relationship between personal interaction and innovation follows the same pattern reported in the main analyses (Model 7 in Table 2; see also Figure 1). However, process control marginally moderates the effect of knowledge sharing through written contributions ($\beta = 0.53, p < 0.10$) in an unexpected positive direction. These interesting findings deserve further discussion.

Insert Table 3 about here

Discussion

There is an increasing pressure on ICU nurses to provide high quality care (Flaatten 2012), which may be achieved through better communication and increased knowledge sharing (Pronovost et al. 2004; Rangachari 2008). Yet, as our findings suggest, controlling the quality of care may actually produce a paradox whereby informal communication between nurses is impaired. In this study, we show that knowledge sharing among ICU nurses is positively associated with individual nurse innovation. Furthermore, this positive relationship holds true for all three types of knowledge sharing, namely, through written contributions, organizational communication, and personal interaction. Our study further demonstrates that control of care quality, which has tightened in Denmark, Europe and much of the world (Lilford et al. 2004), may influence the positive relationship between knowledge sharing and innovation in nuanced ways. Particularly, we found that control of care quality weakens the positive relationship between knowledge sharing through *personal interaction* and innovation. In other words, when control of care quality is high within an ICU, informal conversations and voluntary

helping behaviors between colleagues are less likely to foster innovation. This makes sense, since voluntary, spontaneous informal interaction and collaboration are most likely to suffer when nurses face pressure and/or incentives to meet a set of rigid care quality performance criteria (Wright et al. 1993). Furthermore, we found that strong process control in ICUs not only weakens but in fact inverts the positive relationship between knowledge sharing and innovation, as the context of intensive care has witnessed a decreasing number of well-educated nurses and an increase of process control and the use of guidelines potentially threaten the autonomy and experience-based thinking of health care professionals.

Nevertheless, process control was found to marginally strengthen the effect of *written contributions* on innovation in ICUs. Even though this finding was unexpected, perhaps it makes sense in light of the following consideration. In preparing written documents such as research articles, clinical documents and protocols, nurses must necessarily seek foundation in established procedures of providing quality care. Participation in producing and publishing written documents is likely to foster procedural innovations that can be valuable and welcome only if they observe and respect pre-established clinical guidelines. Therefore, the stronger the demands for process control within ICUs, the more likely is that written contributions of ICU nurses contribute to their innovation activities. Finally, we did not find a moderating role of control of care quality on the relationship between *organizational communication* and innovation. This is perhaps because organizational communication, which takes place predominantly in formalized settings such as department meetings, is likely to revolve around administrative, managerial and organizational issues, which are somewhat outside the scope of clinical practice. Thus, process control is unlikely to influence the innovation effects of organizational communications. These findings advance our understanding about the impact of different means of knowledge sharing within different contexts (Yi 2009), and also shed light on how to unleash the potential of human capital to create successful innovative project in healthcare work units when various controls of care quality are in place (Suhonen & Paasivaara 2011).

It is also worth considering why *process control* was the only control measure that exerted an influence on the relationship between knowledge sharing and innovation. We argue that a strong focus on operational excellence, controlled by measures of care quality, may make knowledge sharing between nurses anchored in efficiency themes rather than innovations. *Structural control* shows no moderating effect perhaps because ICU nurses feel that how the provision of care is organized and structured is beyond the scope of their communication and innovation efforts. Also, *outcome control*, which measures patient benefits, is the end, rather than the means, of nursing practice, and can arguably be reached through either operational excellence or innovation.

Implications for nursing management

Our findings suggest several implications for nursing management. First, hospital administrators may consider loosening process control to stimulate nurse innovations, while personal interaction between

ICU nursing staff is encouraged. Alternatively, managers may consider developing a climate with appropriate incentive systems where helping others, with an emphasis on younger colleagues, is appreciated to offset the negative effects of strong process control (von Krogh 1998). Mentoring programs and/or programs that provide accessibility to the time and attention of experts and senior colleagues may be put in place. Another way to improve the innovative effects of personal interaction is for hospital administrators to undertake proactive efforts to endorse innovation. For example, they may coordinate knowledge exchange by setting up project debriefings and other forms of learning-oriented conversations (Rangachari 2008). In fact, administrators are advised to consider a combination of several initiatives, since a multifaceted approach has been shown to be most effective (Cook et al. 2004).

Conclusion

This study broadly contributes to health care and innovation management, given that the barriers and enablers of effective knowledge management in health care parallel those observed in other industries. We demonstrate that the increasing pressures to implement control of care quality *and* innovate may be conflicting, unless handled properly. Our findings that knowledge sharing is related to innovation, but only under certain conditions, is most likely to generalizable to a wide variety of settings. We hope this study may inspire future research to fully capture the complexity embedded in the relationship between knowledge sharing and innovation for clinical professionals with alternative and complementary research designs and methodologies.

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Table 1**Summary statistics and correlations between study variables ^a**

	<i>M</i>	<i>SD</i>	1	2	3	4	5	6	7	8	9
1 Innovation	3.21	0.74									
2 Knowledge sharing through written contributions	1.80	0.65	0.53 [*]								
3 Knowledge sharing through organizational communication	2.89	0.65	0.51 [*]	0.60 [*]							
4 Knowledge sharing through personal interaction	2.50	0.51	0.32 [*]	0.30 [*]	0.31 [*]						
5 Control of care quality	4.43	0.33	0.04	0.02	0.07	0.08					
6 Intensive care nursing training (0 = no, 1 = yes)	0.80	0.40	0.08	0.32 [*]	0.25 [*]	0.02	0.02				
7 Age	44.13	9.77	-0.07	0.11	0.14	-0.10	-0.05	0.36 [*]			
8 Sex (0 = male, 1 = female)	0.95	0.23	0.00	0.00	0.14	0.14	0.18 [*]	-0.02	0.01		
9 Tenure as nurse	16.79	9.84	-0.06	0.20 [*]	0.26 [*]	0.00	-0.04	0.43 [*]	0.83 [*]	0.03	
10 Number of working hours per week	34.47	3.76	0.07	0.15 [*]	0.15 [*]	0.11	-0.04	0.03	-0.06	-0.12	-0.07

^a *n* = 180^{*} *p* < 0.05

Table 2**Results of main OLS regression analysis^a**

	<i>Model 1</i>	<i>Model 2</i>	<i>Model 3</i>	<i>Model 4</i>	<i>Model 5</i>	<i>Model 6</i>	<i>Model 7</i>
Knowledge sharing through written contributions (KSWC)		0.37**	0.45**	-0.66	0.46**	0.45**	-1.94
Knowledge sharing through organizational communication (KSOC)		0.41**	0.49**	0.50**	0.37	0.50**	1.12
Knowledge sharing through personal interaction (KSPI)		0.20*	0.13	0.14	0.13	1.94	2.73*
Control of care quality			0.13	-0.30	0.06	1.17	1.07
Control of care quality x KSWC				0.25			0.53
Control of care quality x KSOC					0.03		-0.13
Control of care quality x KSPI						-0.41	-0.59*
Intensive care nursing training (0 = no, 1 = yes)	0.28 [†]	0.03	-0.11	-0.11	-0.11	-0.12	-0.12
Age	-0.01	0.00	0.00	0.00	0.00	0.00	0.00
Sex (0 = male, 1 = female)	0.04	-0.26	-0.51*	-0.54*	-0.51*	-0.51*	-0.57**
Tenure as nurse	0.00	-0.02*	-0.02*	-0.02*	-0.02*	-0.02*	-0.02*
Number of working hours per week	0.01	-0.02	-0.02*	-0.03*	-0.03*	-0.02*	-0.03*
Intercept	3.08**	1.78**	1.64 [†]	3.60 [†]	1.99	-2.89	-2.38
<i>R-squared</i>	0.03	0.41	0.50	0.51	0.50	0.51	0.52

^a *n* = 180** *p* < 0.01* *p* < 0.05[†] *p* < 0.10

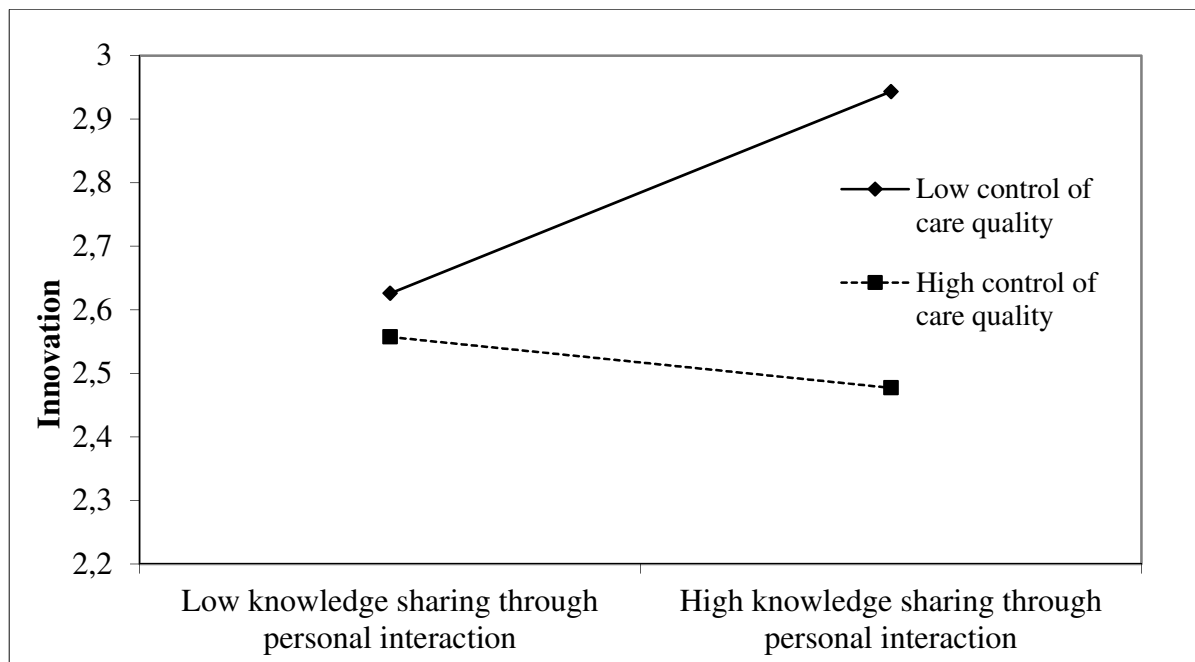
Table 3**Results of auxiliary OLS regression analysis ^a**

	<i>Model A1</i> <i>Main effects only</i>	<i>Model A2</i> <i><u>CCQ</u> = Structural control</i>	<i>Model A3</i> <i><u>CCQ</u> = Process control</i>	<i>Model A4</i> <i><u>CCQ</u> = Outcome control</i>
Knowledge sharing through written contributions (KSWC)	0.49 ^{**}	-0.76	-1.92	-0.72
Knowledge sharing through organizational communication (KSOC)	0.47 ^{**}	1.85 [†]	0.47	-0.11
Knowledge sharing through personal interaction (KSPI)	0.14	0.91	3.80 ^{**}	1.61
Structural control	0.05	0.94	0.05	0.06
Process control	-0.37 [†]	-0.38 [†]	0.70	-0.33
Outcome control	0.56 [*]	0.56 [*]	0.57 [*]	0.46
<u>CCQ</u> x KSWC		0.28	0.53 [†]	0.26
<u>CCQ</u> x KSOC		-0.31	0.01	0.14
<u>CCQ</u> x KSPI		-0.18	-0.82 ^{**}	-0.33
Intensive care nursing training (0 = no, 1 = yes)	-0.14	-0.14	-0.18	-0.14
Age	0.00	0.00	0.00	0.00
Sex (0 = male, 1 = female)	-0.52 [*]	-0.55 [*]	-0.57 ^{**}	-0.54 [*]
Tenure as nurse	-0.02 [*]	-0.02 [*]	-0.02 ^{**}	-0.02 [*]
Number of working hours per week	-0.02 [*]	-0.03 [*]	-0.02 [*]	-0.02 [*]
Intercept	1.17	-2.57	-3.69	1.41
<i>R-squared</i>	0.52	0.54	0.56	0.53

^a The abbreviation CCQ stands for “Control of Care Quality”. *n* = 180^{**} *p* < 0.01 ^{*} *p* < 0.05 [†] *p* < 0.10

Figure 1

The interactive effect of knowledge sharing through personal interaction and control of care quality



Note: The plot is based on results reported in Table 2, Model 7.

Appendix: Survey items

Innovation

1. Coming up with new ideas
2. Working to implement new ideas
3. Finding improved ways to do things
4. Creating better processes and routines

Knowledge sharing

Written contributions

1. Participate in writing a research and development article (e.g., for a nursing journal)
2. Participate in writing local clinical guidelines
3. Participate in writing national clinical guidelines (i.e., sent to Clearing House for Clinical Guidelines)
4. Inform colleagues in writing about the projects you participate in
5. Contribute to the development of protocols to improve care in your department
6. Discuss staffing issues through group emails or online discussion forums

Organizational communication

7. Participate in a journal club
8. Participate in problem-solving during department meetings
9. Answer others' questions during department meetings
10. Ask question during department meetings
11. Tell success stories of nursing experiences that could benefit your department
12. Tell colleagues about adverse events during department meetings

Personal interaction

13. Support a less experienced colleague outside of your normal working hours
14. Spend time on personal conversations with other critical care nurses to help them with work-related problems (e.g., conversations over lunch, over the phone)
15. Discuss organizational issues in informal contexts
16. Use your own experience in informal contexts to help colleagues avoid accidents
17. Chat online (e.g., in Facebook groups) to help colleagues with their work-related problems
18. Spend time on personal e-mail correspondence with other intensive care nurses to help them with their work-related problems

Control of care quality

Structure

1. Presence of ICU medical director
2. Daily rounds by an intensive care physician
3. ICU nurse-to-patient ratio

Process

4. Use of barrier precautions while inserting central venous catheters
5. Daily interruption of sedation
6. Rate of self-extubation
7. Appropriate use of stress ulcer prophylaxis
8. Appropriate use of deep venous thrombosis prophylaxis

Outcome

9. Minimization of sepsis
10. Minimization of length of ICU stay
11. Minimization of ventilator-associated pneumonia
12. Minimization of the duration of mechanical ventilation
13. Minimization of the consumption of medicines
14. Optimization of pain management
15. Optimization of family and patient satisfaction with care
16. Optimization of end-of-life care